ENERGY FOR SUSTAINABILITY

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Abstract- In recent years, Bangladesh has suffered from sporadic shortages in electricity due to the rising energy demand faster than expected. Numerous policies have been reformed by the government over the past decades to balance country's electricity demand and to create level playing field for both public and private sectors in order to bring reliable energy for more Bangladeshis in a smartest ways. Recently, the government has declared vision of electricity for all by 2021. Even though numbers of strategic initiatives have been put in place, the power sector vision has yet to be achieved. Thus, the power sector was perceived to be riddled with some fundamental weaknesses, which necessitated initiation of the reform process in the sector. This paper highlights a comprehensive overview of Bangladesh's energy sector and identifies a set of challenges for policy makers attempting to influence the process of transforming the energy sector. Further concentrations were given on the basic understanding of overarching energy policy framework and features in energy sector. Finally, key energy challenges appearing across individual energy sectors were discussed and offered a strategic perspective into Bangladesh's energy sector as a whole.

Index Terms- Energy, Stratigetic Perspective

I. INTRODUCTION

In recent years, the government of Bangladesh has decided to increase share of coal based power production to 50% by 2030 to overcome energy shortage solve energy problem [1]. However, the encouragement of capital investments in cutting-edge clean coal energy technologies is desired to confront climate change and environmental pollution. Accordingly, the on-going measures to achieve the coal dependent power generation targeted by 2030 have been contentious. Further, implementation nuclear energy in Bangladesh is unlikely to be attractive because of the lack of recourses, skilled manpower, decommissioning and radioactive waste management challenges.

Therefore, it is essential to comprehend the policy objectives and context to understand the dynamics of the energy policy framework governing Bangladesh's energy sector. However, in the Bangladesh context, there are only a handful of studies that have attempted to understand the dynamics of the energy policy framework and identify the challenges towards achieving the country's energy vision.

Accordingly, this study fills the gap in energy by studying a comprehensive overview of Bangladesh's energy sector and identifies challenges towards achieving the country's energy visions. Further concentrations were given on the individual fuel sectors, the basic understanding and significant features of overarching energy policy framework. Finally, the key energy challenges appearing across individual energy sectors were discussed and offered a strategic perspective of energy sector as a whole.

II. ENERGY INITIATIVES

With an objective to provide 24,000 MW across the country by the year 2021, the government has been taken several landmark decisions in all generation options (natural gas, oil, coal, hydro wind, solar and nuclear) in addition to increased efficiency and conservation in its use. The policies to encourage the affordable energy initiatives are described in subsequent sections.

A. Gas Fired Power Plant

Bangladesh gas sector was started the journey of gas based power plant in the 60s, but its rapid expansion and integration started to accelerate in the early 70s. In Bangladesh, natural gas is one of the most important sources of energy that accounts for 61% of the total energy production. The 25 discovered gas fields in the country cumulatively possess approximately 27 trillion cubic feet (Tcf) of gas (proven and probable) of which 11 plus Tcf has been used [2]. The supply supply capacity of Petrobangla is 900 mmcfd against the demand of 1,200 mmcfd in Bangladesh for power generation [2]. The shortfalls in gas supply in 2025 for the proved, probable, and possible reserves are expected to be 13.1 trillions of cubic feet (Tcf), 8.5 Tcf, and 4.6 Tcf respectively. According to United States Geological Survey, there is a possibility of undiscovered reserves of 32.1 Tcf [3]. Current gas reserves are expected to meet the country's demand only up to 2019 [4]. The estimation of gas reserve by Petrobangla suggested that the country would be required 58.2 Tcf of gas to meet its demand till 2050. Lately, production sharing contracts (PSC) with Australian oil and gas company Santos, and Singapore-based Kris Energy have been by Petrobangla to explore oil and gas in shallow water in

the Bay of Bengal [5]. However, no new commercially viable gas field has been discovered in recent years. Under the current scenario, indigenous gas supply will not be able to meet these demands and the existing recoverable reserve of natural gas would be depleted within next one decade. Other aspects of this challenge are discussed in subsequent sections, which address the importance of improving the current energy shortfalls.

- Capacity building policy of local exploration company
- Cross-border energy trade
- Combined cycle power conversion
- Fuel diversification

B. Oil-fired power plant

Oil imports has been rising in recent years as the country reduced dependency on natural gas for power generation by setting up fuel oil-based power plants. Petroleum products account for a fourth of total commercial energy use in Bangladesh. The government tackled the deteriorating power situation by installing 79 oil-fired rental and quick power plants, of which 47 under private and public sectors [6]. However, the country has to pay higher rates of power tariff for getting electricity from costly liquid fuel based power plant. The upward power tariff adjustment will be continued in future with increased liquid fuel import bills if the base load power generation capacity will not improve with comparatively cheaper fuels like coal and gas. Besides, the growing gaps for primary fuel supply for power generation will be made the power generation capacity achievement unsustainable unless urgent coordinated initiatives are taken [7]. While the government`s large and ambitious development programs specially in power sector were well conceived, there were many challenges that need to be addressed.

- Lack of fuel supply chain
- Lack of infrastructure and storage facility

C. Coal Fired Power Plant

The demand of coal-fired electricity projected to increase 15% by 2040 globally. Thus, many of the countries have been introduced low carbon growth strategy to reduce carbon emissions [8]. About 75% of operating coal-fired plant around the world is being used less efficient, non-HELE technology [9]. In recent years, the government has undertaken a massive plan to set up high-capacity imported coal-based power plants to meet the demand through providing less expensive electricity. Presently, only one Barapukuria coal mine power plant in the country operating since 2005 produces 250 MW. Power System Master Plan (PSMP) was jointly drafted in 2010 by the Ministry of Power, Energy and Mineral Resources, the Japan International Cooperation Agency (JICA), The Tokyo Electric Power Co., Inc. (TEPCO) and the Bangladesh Power Development Board (PWDB) to provide access to affordable and reliable electricity to all citizens by 2021. Ambitious initiatives have been taken by Bangladesh government to generate around 18,000MW of coal-fired electricity. According to the power and energy sector update roadmap [10], government of Bangladesh adopted plans for generating 20,000 MW power in line with the vision 2021. The generation capacity will be increased to 34,000 Megawatts by 2030 to attain the desired rate of economic development, according to the PSMP 2010 [11]. The plan was later reviewed in 2016, with an updated power-generation roadmap to facilitate Bangladesh's ambition to become a developed, advanced nation by 2041 under the vision 2041 program of the government [12]. it was intended by the government to shift for 50% coal based electricity development according to power system master plan 2010 [11]. However, concrete action plans and their implementations, both for securing investments and for infrastructure developments will be needed to meet the demand. Moreover, achieving the 50% coal dependent power generation target by 2030 has been put a number of challenges shown below:

- Infrastructure development
- Coal transportation zone
- Safest zone from natural disasters
- Cross border trade
- Domestic source of coal
- Environmental concern

D. Transmission And Distribution System

Transmission capacity in Bangladesh is mismatched with growth of power generation capacity growth of power generation capacity. The distribution and management system has not been updated to maintain high security and reliability of the system. Perpetuate concerns is the security and stability of the country's power grid due to the periodic power outage [13]. Due to the scarcity of natural resources, it is vital to bring in effective measures to improve energy efficiency for the growing demands of society and economic growth. The country is facing a significant challenge in revamping its network responsible for the continuous increasing demand and supply of electricity. However, there are reports of power disruption or power cut on the supply side due to limitations of transmission and distribution capacity. Due to the over demand, usually coil nature of the load lags the power factor or additional reactive volt ampere resistance (VAR) power impose additional current flow through the line.

Power demand in megawatt:

$$MW = MVAR \times Cos\theta$$

Where, MVAR is megavolt ampere resistance and Cosθ is the power factor. The high demand of major inductive loads ultimately intend to increase the line current. Therefore the resistive or dissipative loss is promoted. There is always additional loss of power through the resistive heating effect of additional current for over demanding load. The proper policy management in power transmission and distribution stages, the severity of losses can be reduced bit gradually. The additional measures to network reconfiguration including transmission line replacement by using bigger diameter of conductor, insulation replacement, establishment of capacitor bank to minimize power factor loss, load balancing and high voltage transmission should be taken to ensure the loss minimization and resulted in cost optimization [14]. The conventional distribution system should be restructured to smart distribution system to address the power crisis and other problems [15].

Automated technologies that may bring important benefits to the existing transmission and distribution (T&D) networks of Bangladesh. The high voltage direct current (HVDC) power transmission in the existing grid is so sensitive to load management. In the transmission network, flexible and reliable transmission capabilities can be facilitated by the advanced Flexible AC Transmission Systems (FACTS), high-voltage dc (HVDC) devices, and other power electronics-based devices. Implementation of other renewable energy generation technologies energy fed with the existing line, the FACTS should be practical approach [16]. Smart grid (SG) could be a leading tool towards the development of digital Bangladesh as it controls the supply and demand of electric power using advanced communication technology. Due to insignificant uses of peak current by the household users in Bangladesh, the SG concept mainly implementable for the monitoring of load balance between the transmissions distribution network (same or different owners) not for individual subscribers.

III. PROBLEM WITH EXISTING TRANSMISSION LINE (TL)

The existing grid is old, electrically weak and there is scope for improvement according to the recommendations given by the experts in the past [17-19].

- Long distances from grid substation, inadequate diameters of the conductors or conductor size for additional load demand, lack of adequate high voltage transmission and medium voltage distribution line resulted in frequent system overload, poor voltage profiles and high technical losses in rural T&D.
- Cascading failures of high voltage direct current transmission (HVDC) line in Bangladesh was initiated a widespread blackout in the country. Transient effect of the transmission system can be minimized by integrating the HVDC to the TL to make the weak grid electrically strong and stable.
- Glitch Effect in power system causes failure to perform the duty of blackout preventer due to major imbalance between the real time generation and consumption process. The HVDC back-to-back station at Bheramara was experienced in power of Bangladesh.

Recommendation for the transmission and distribution system:

As per PSMP 2010 our generation capacity would be 16,000 MW by the year 2016, 24,000 by 2021 and 40,000 by 2030. Besides generation, we have to develop required transmission links and supplement the distribution network accordingly. Up to 2020 about 4000 km of new transmission lines and 120,000 kilometres distribution lines need to be constructed [20].

Estimated investment would be USD 40.0 billion [20].

To achieve the target of adequate power supply for all by 2021, the government needs to ensure proper implementation of the allocated money for the power and energy sector [21].

Additional feeder from cross broader power supply may reduce the effective load therefore current in the existing transmission line would to be minimized for sustainable and efficient power supply.

Distribution transformer proper load management may enhance its efficient operation for the growing areas for electricity demand.

Managing demand is crucial term to mitigate many ways to shrink tip power needs. It is related to the periphery huge customers to limit electrical usage on demand.

Gas insulated switch gear in power substation and distribution should be incorporated to retain minimum loss of the high voltage transmission and distribution system.

Performance analysis based safeties and control strategy of the converter station should be fixed.

Timings and set points of the protection relays should be maintained uniformly.

Smart data communication and monitoring system should be introduced to the grid system to reduce line loss and improve efficiency.

Round-the- clock liaison between generation and distribution can be introduced to prevent blackout in power supply system.

Investments should be stimulated in intelligent energy-active distribution network technologies, high voltage direct current (HVDC), ultra-high voltage alternative current (UHVAC) system to minimize the loss long-distance transmission schemes.

Demand side efficiency should be improved to save up to 30% energy [22]. May be mentioned that 20% of the peak demand (34000 MW) required by 2030 can be minimized amounting 27000 MW through the improvement of demand side efficiency.

The integrated resource plan (IRP) for electricity generation should be introduced to improve the long term reliability of electricity supply through meeting adequacy criteria over and above keeping pace with economic growth and development.

Large investments are necessary to construct medium voltage distribution line and high voltage transmission lines with suitable sub-stations in order for additional electricity to reach rural consumers.

Separate allocation for the maintenance and modernisation of age-old power plants and ensuring good governance should be required.

Along with making use of donor funds, the government should look into options that can encourage private participation in investing in T&D systems.

The government should work for better coordination between transmission, consumption and production to robust power transmission system on all levels.

By undertaking an integrated resource planning, Bangladesh can become the leader of a new world that would help leaving a more livable planet for the next generation. It should be kept in mind that that will technology transform existing and future infrastructure into truly smart networks, capable of serving a wide variety of customers and generation sources and what impact will electric vehicles have on network infrastructure?

CONCLUSION

Modern societies need a reliable supply of energy being delivered under reasonably predictable prices and conditions and in an environmental sustainable way. Various initiatives and strategic approaches have been taken by the government in the past few years to mitigate the crisis of electricity. One of the biggest concerns was the gap in the demand and supply of power in Bangladesh. It could not be very much useful for the government to spend high amount of money as subsidy for running the quick-rental power plant projects. Thus, government has to phase out rental and quick rental power plants and simultaneously need to enhance base-load capacity. Several institutional reforms are necessary to prepare for upcoming energy challenges rather than plan actions on an ex-post facto basis. The government need be ensured the supply of coal in power generation by removing political deadlocks in domestic coal mining. Almost all the coal projects are at very early stage of implementation. Coal terminal with storage facilities, sourcing coal from abroad, signing long term supply agreement, setting-up supporting coal import infrastructure, transportation, engaging contractors, and clean coal project implementation are major challenges. Regulatory reform should be required to pursue the utilisation of domestic resources and promote indigenous energy technologies by joint-ventures in mining sectors and developed an optimum petroleum inventory to enhance the energy security in the long term. It is the crucial requirement for extensive capacity building of technical and managerial persons for managing the projects implementation and operation of the mega coal-fired plants. The more proactive approach for own coal mining is the best possible mining method and starting energy diplomacy with coal suppliers should be implemented to achieve power to all vision by 2021. Effort has to be strengthen and continue to create regional energy market along with pursuing joint exploitation of regional hydro-electric resources in the scope of SAARC. Apart from that power imported from Nepal, Bhutan and eastern Indian states are under discussion, government should negotiate successfully in multilateral power trading and need to initiate physical implementation of joint venture power grid connectivity for regional power trading.

There are also huge challenges ranging from securing investment, reducing system loss, improving efficiency, structuring appropriate pricing, developing competent manpower. Private sector participation should be promoted to develop transmission and distribution line capacity of the country. Further, the need for a smart grid is explored for better efficiency, reliability, with possible integration of renewable and alternate energy sources. Government need to emphasize on competition and transparency besides implementing a clear regulatory framework, namely tariff reforms and private public participation (PPP) to make the energy sector attractive to huge capital flow. From the government side, sustainable energy policies backed up by financial support is required to promote the participation of private sectors. Government should make provision of electricity for un-served remote areas populations through solar energy. The sustainable credit enhancement mechanism for funding in renewable energy sector needs to be put in place through increased participation by global funding agencies.

In response to a question about how Bangladesh would dispose of uranium since it had no experience in nuclear waste disposal and technical expertise or skilled manpower to undertake such a project. Russia has agreed to dispose of spent reactor fuel from the proposed Rooppur nuclear power plant and transport

the highly radioactive rods back to Russia at the end of their life-cycle. The main challenge of Bangladesh is the temporary storage of the radioactive fuel rods after the end of their use and the transportation of the fuel rods to and from the plant. Further, it may need to supply few thousands of gallons of water per minute for emergency cooling. However, the extraction of 75 per cent of water during the lean summer months by India from Farakka Barrage causes heavy silt over the proposed upstream site (40 Km) of River Padma. Thus, adequacy of water for the emergency period of the nuclear plant is the major challenge for the plant which needs to be taken into account by the government. Commitment should be provided by the Government to provide fund for the alternative waste storage and disposal techniques of nuclear waste. Realizing Bangladesh's energy objectives, whether at the pace anticipated in the new policies scenario or at the accelerated tempo of the country's vision case, will be required sustained investment, at levels that necessitate calling upon large-scale flows of private and foreign capital. Action-oriented national commitment from all stakeholders, regulatory bodies and support from the development partners, academia and private sectors might be required to fulfill the aspiring target of 'electricity for all by 2021'.

REFERENCES

[1] Kotikalapudi CK. Corruption, crony capitalism and conflict: Rethinking the political economy of coal in Bangladesh and beyond. Energy Research & Social Science. 2016 ;17:160-4.

[2] Rahman M. Primary energy supply challenges for power, March 08, 2015

[3] Wandrey CJ. US Geological Survey-PetroBangla cooperative assessment of undiscovered natural gas resources of Bangladesh; petroleum systems and related geologic studies in Region 8, South Asia. 2001.

[4] Energy policy options for bangladesh, keystone quarterly review, jan-mar 2014, volume 7.

[5] jahangir s. santos-krisenergy jv to drill well at magnama in dec, 1 september, 2015

[6] Ahmed N. Coal-fired power plants crucial for Bangladesh, the Daily Observer. 9 September, 2016.

[7] Forbes BD, Allen LJ. Modeling energy-loss spectra due to phonon excitation. Phys. Rev. B: 2016;94(1):014110.

[8] IEA. World energy outlook 2014,

[9] Technology roadmap: High-efficiency, low-emissions coal-fired power generation,

[10] Power and Energy Sector Road Map : An Update June 2011

[11] Power System Master Plan 2010, February 2011

[12] Jamal Sakib, The Case for Coal in Bangladesh,AUGUST 1, 2016

[13] Rahman, K.M. Mahbubur 2015 Why grid failure occurs, causing a blackout, Daily star.

[14] Ghosh S. Loss Reduction and Efficiency Improvement: A Critical Appraisal of Power Distribution Sector in India. International Journal of Modern Engineering Research. 2012 Sep;2(5):3292-7.

[15] Ericson T. Time-differentiated pricing and direct load control of residential electricity consumption.2006.

[16] Santacana E, Rackliffe G, Tang L, Feng X. Getting smart. IEEE Power and Energy Magazine. 2010 ;8(2):41-8.

[17] Nikolakakis T, Chattopadhyay D, Bazilian M. A review of renewable investment and power system operational issues in Bangladesh. Renewable and Sustainable Energy Reviews. 2017; 68:650-8.

[18] Afrin S. Monetary policy transmission in Bangladesh: Exploring the lending channel. Journal of Asian Economics. 2016.

[19] Primary grid system of bangladesh (As on June, 2015),

[20] Hossain M. Power Sector Success & Challenges Ahead, Energy and Power, 2016.

[21] Spangler AR. The Economical Loading of Distr*ibution* Transformers. IEEE Transactions on Industry Applications. 1977;2(IA-13):120-4.

[22] Tamim M. Integrated resource planning and the power sector, Daily star, February 01, 2016.

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